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Virus-inspired design principles enable the economical self-assembly of complex crystalline membranes

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As first suggested by Caspar and Klug, many viruses assemble icosahedral shells (capsids) because the high symmetry of the icosahedron enables economical assembly—enclosing a large volume with relatively few distinct protein subunit types. A collaboration between Grason, Hagan, and Santangelo generalize this design principle to triply-periodic polyhedra, mesoporous structures approximating cubic minimal surfaces. They demonstrate the programmable assembly of various minimal surfaces from a minimal number of distinct subunits forming arbitrarily large unit cells of tunable, defined size. However, while high symmetry points enable economy in these target structures, they can also serve as seeds of misassembly. This design strategy, and the fundamental tradeoff between economy and fidelity, lays the groundwork for deploying rapidly advancing nanotechnology approaches to programmable assembly to achieve size-controlled architectures with tunable functional properties.

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